ISS Earth and Space Science Payload Accommodations

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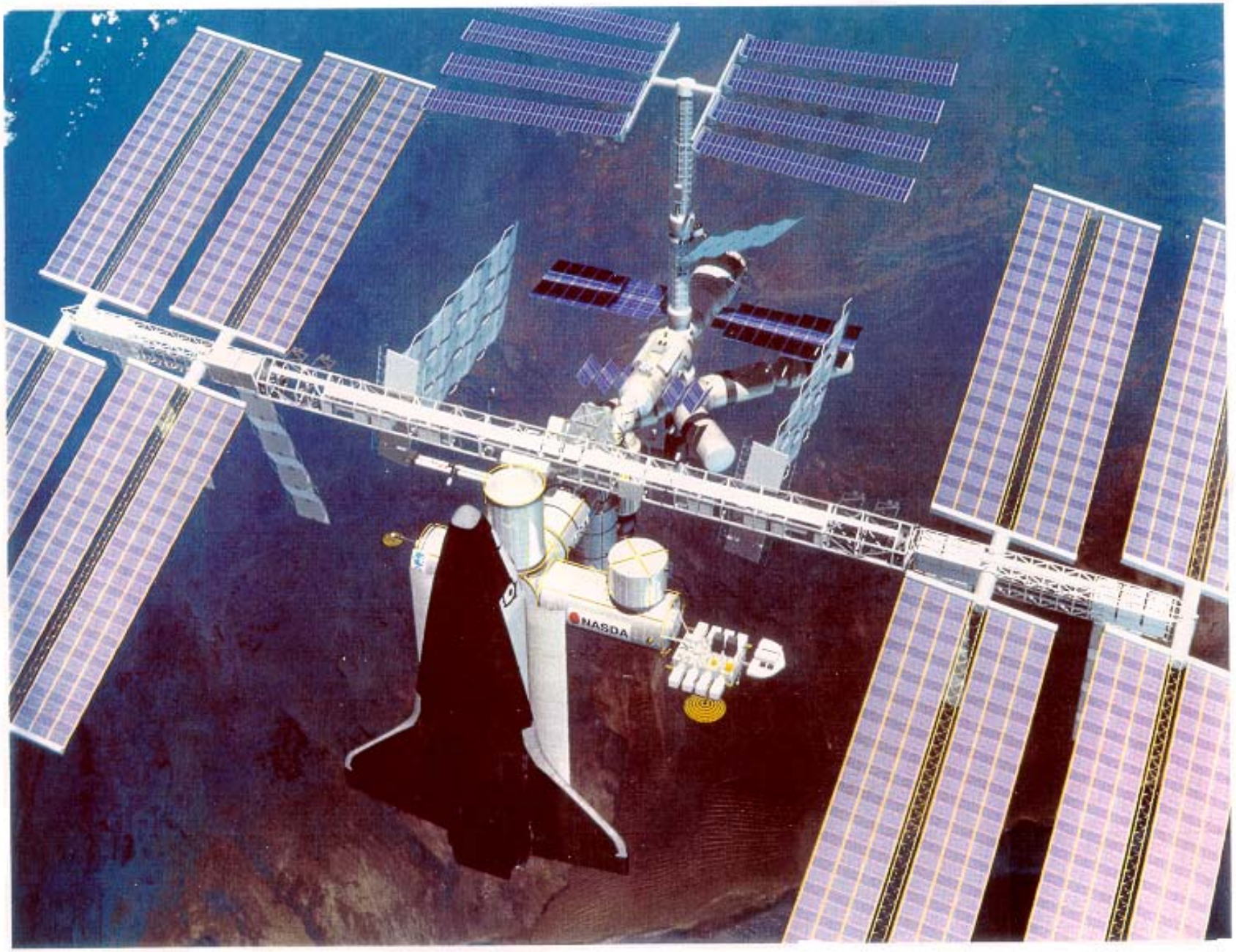
OSS & OES Research Program Office, GSFC

SMEX Pre-Proposal Conference

February 21, 2003

Agenda

- Research Program Office for Space and Earth Science
- Assembly Progress on the ISS
- ISS Attached Payload Site Accommodations
  - Full Truss
  - EXPRESS Pallet
  - JEM-EF
  - WORF
- General Payload Considerations
  - Safety
  - Crew Training
  - Operations Concept
  - Payload Retrieval
- GSFC RPO Website Contact


NASDA

GSFC Research Program Office Function

- Code 804 ISS Research Program Office is responsible for managing the Office of Space Science (OSS) and the Office of Earth Science (OES) payload activities on the International Space Station (ISS)
- Headquarters Level II Office at GSFC, the Research Program Office (RPO) acts as the primary interface between the OSS and OES, the ISS Program, and the space and earth science payloads

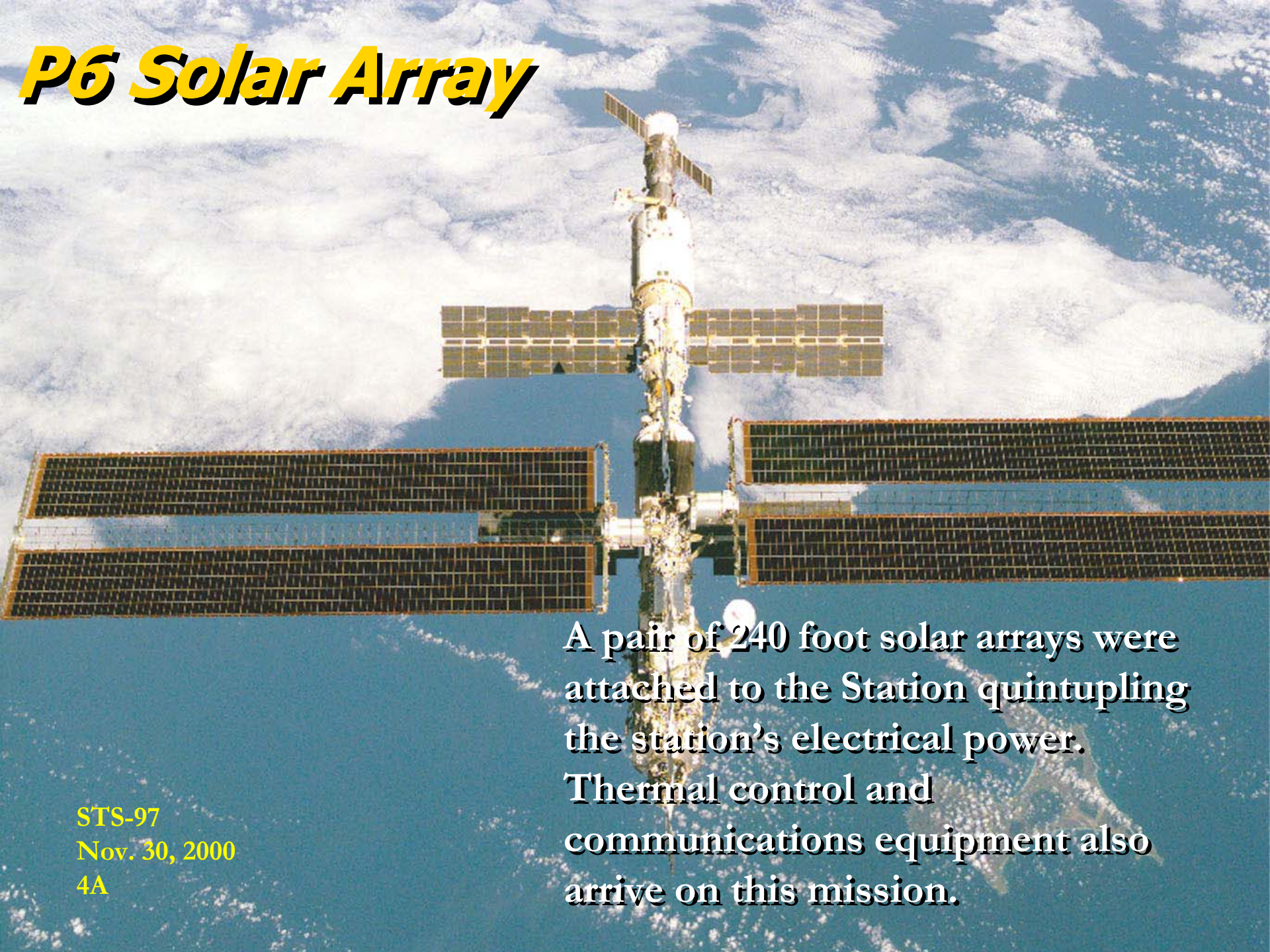
RPO Role for Payload Support

- Coordinate payload planning, accommodations, allocations, manifesting, development, integration, and operations, and any associated issues between HQ, payload developers, international partners, other NASA centers, and the ISS Program
- Assist ISS Program/Boeing in defining payload interface requirements including thermal, mechanical, electrical, data, contamination, operations, crew training, programmatic (schedules, data deliverables, documentation, reviews)
- Shepherd payload developers through the STS/ISS systems, procedures, and reviews

ISS January 1999


ISS October 2000

P6 Solar Array

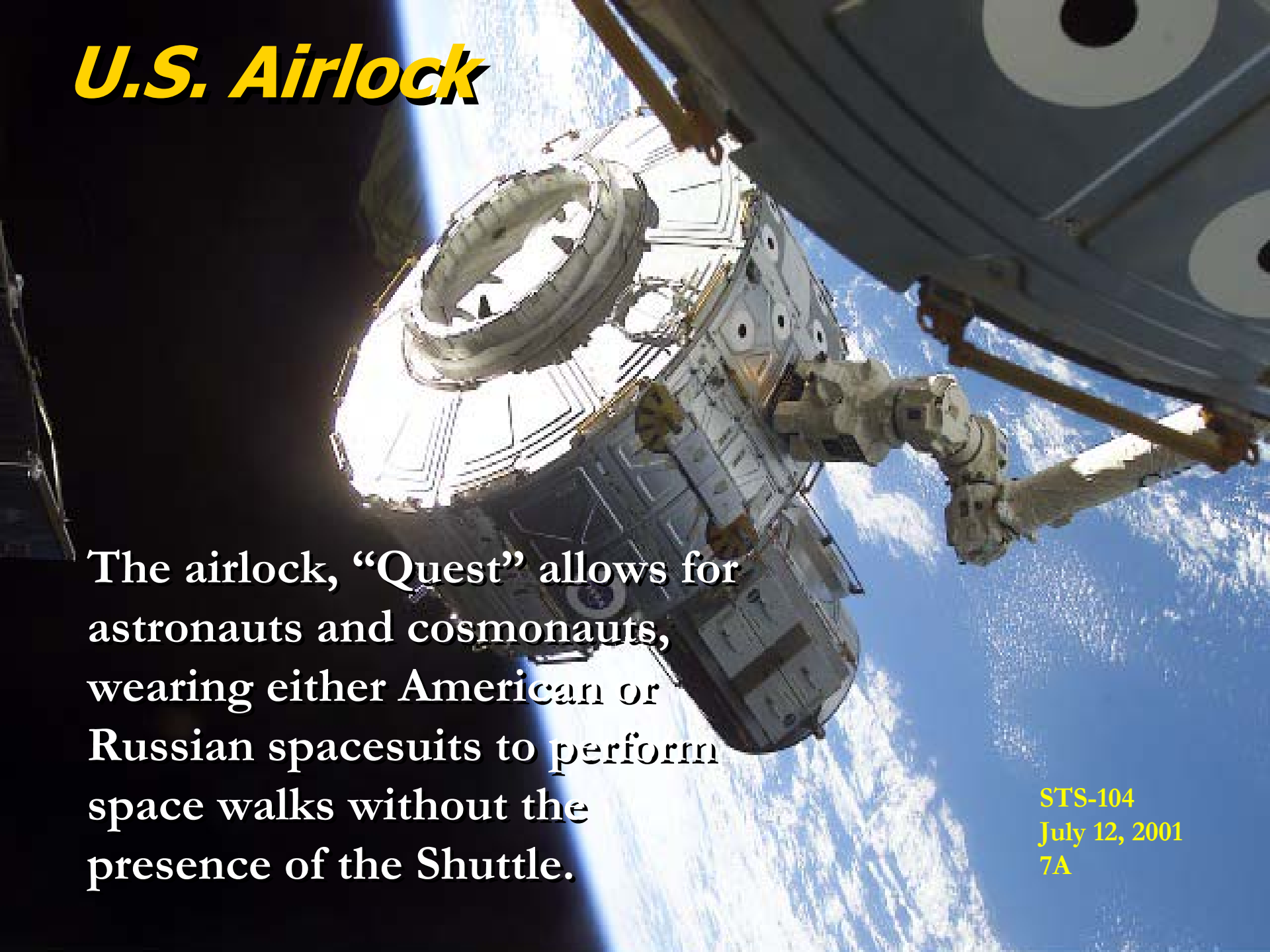


A pair of 240 foot solar arrays were attached to the Station quintupling the station's electrical power. Thermal control and communications equipment also arrive on this mission.

STS-97
Nov. 30, 2000
4A

CanadaArm 2

U.S. Airlock



The airlock, "Quest" allows for astronauts and cosmonauts, wearing either American or Russian spacesuits to perform space walks without the presence of the Shuttle.

STS-104
July 12, 2001
7A

Russian Docking Compartment

Provides second
EVA Airlock

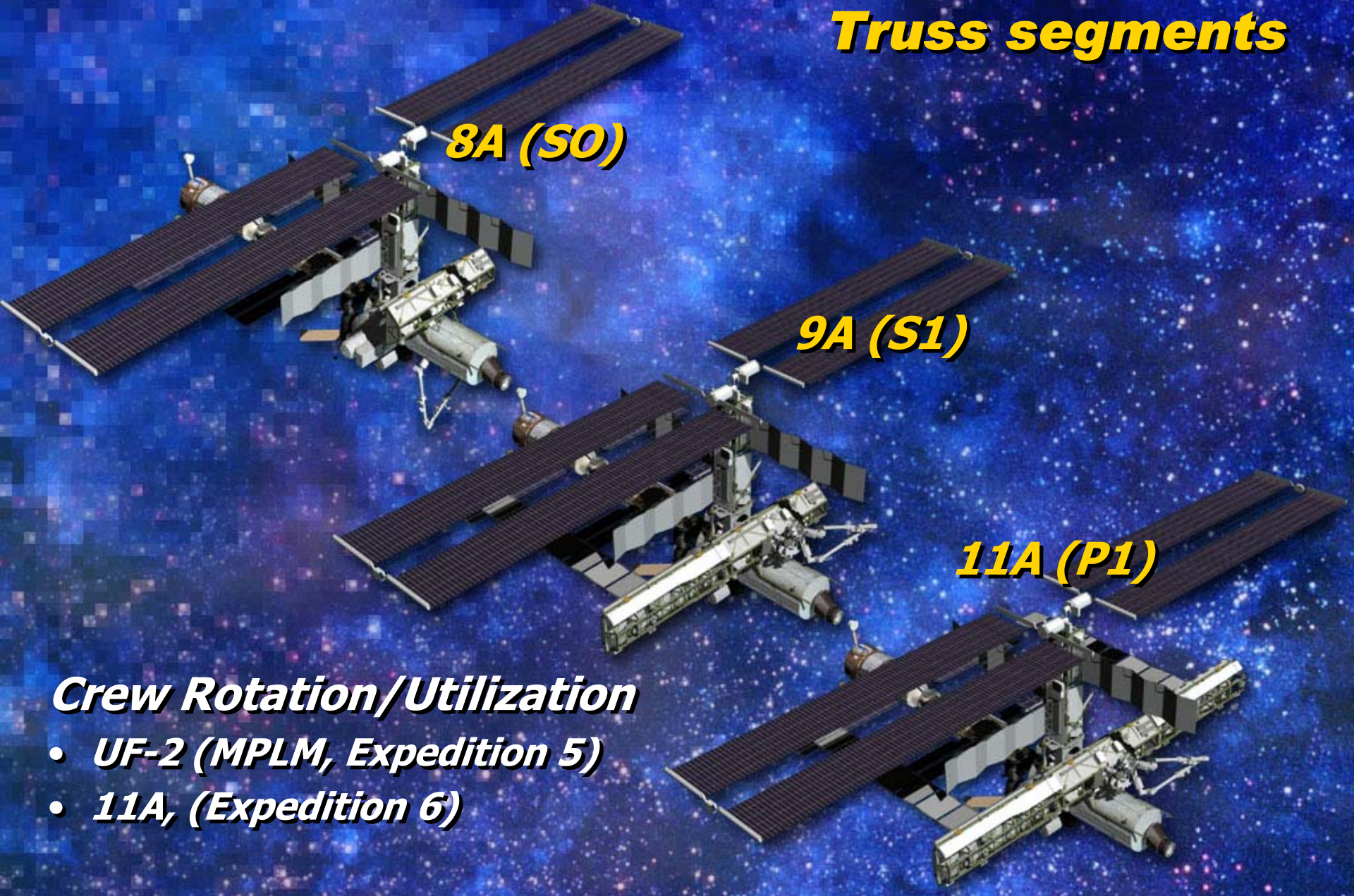
ISS 4R

September 15, 2001

Soyuz launch from Baikonur

ISS November 2001

Truss segments



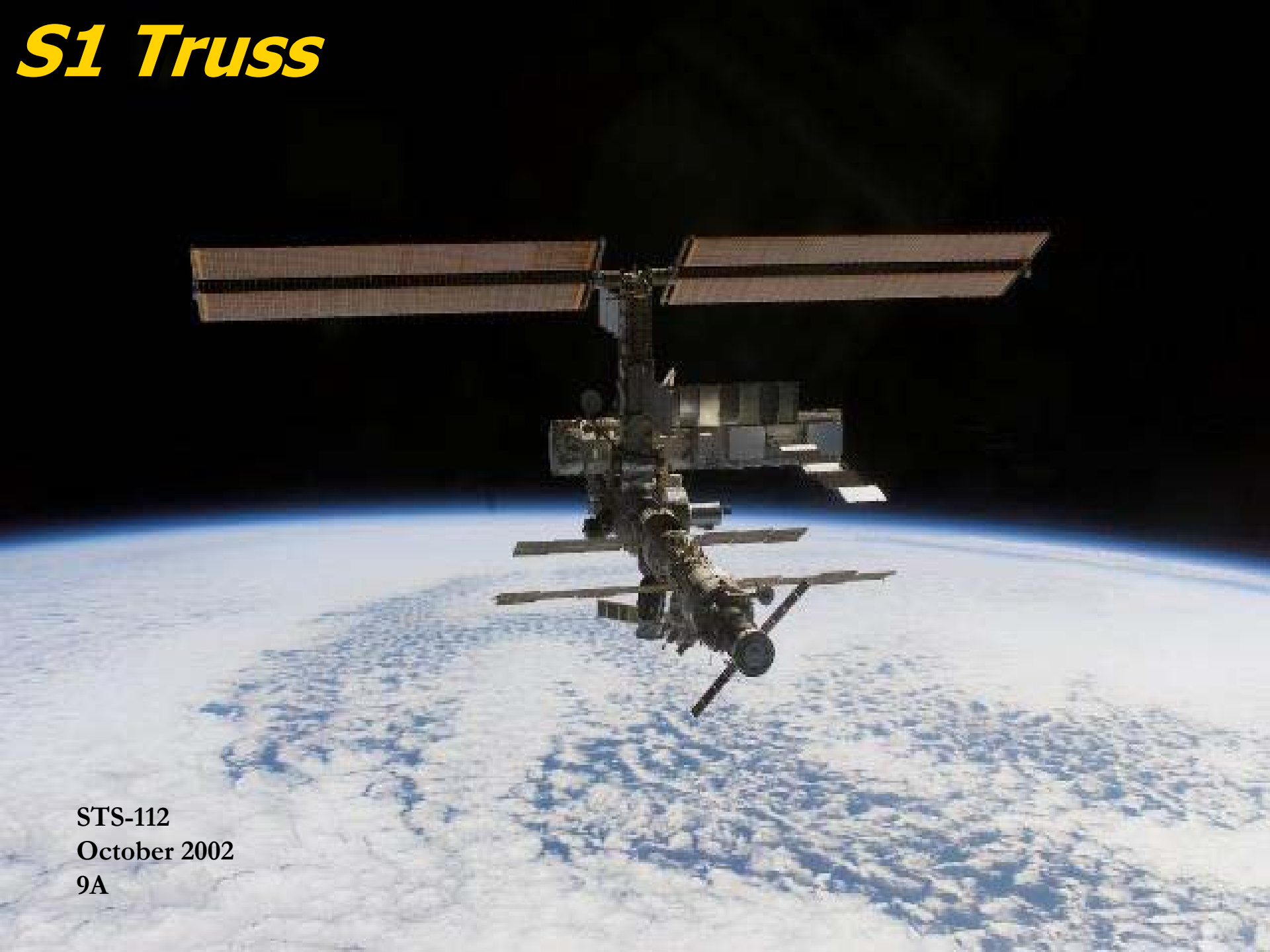
Crew Rotation/Utilization

- UF-2 (MPLM, Expedition 5)
- 11A, (Expedition 6)

S0 (S-zero) Truss

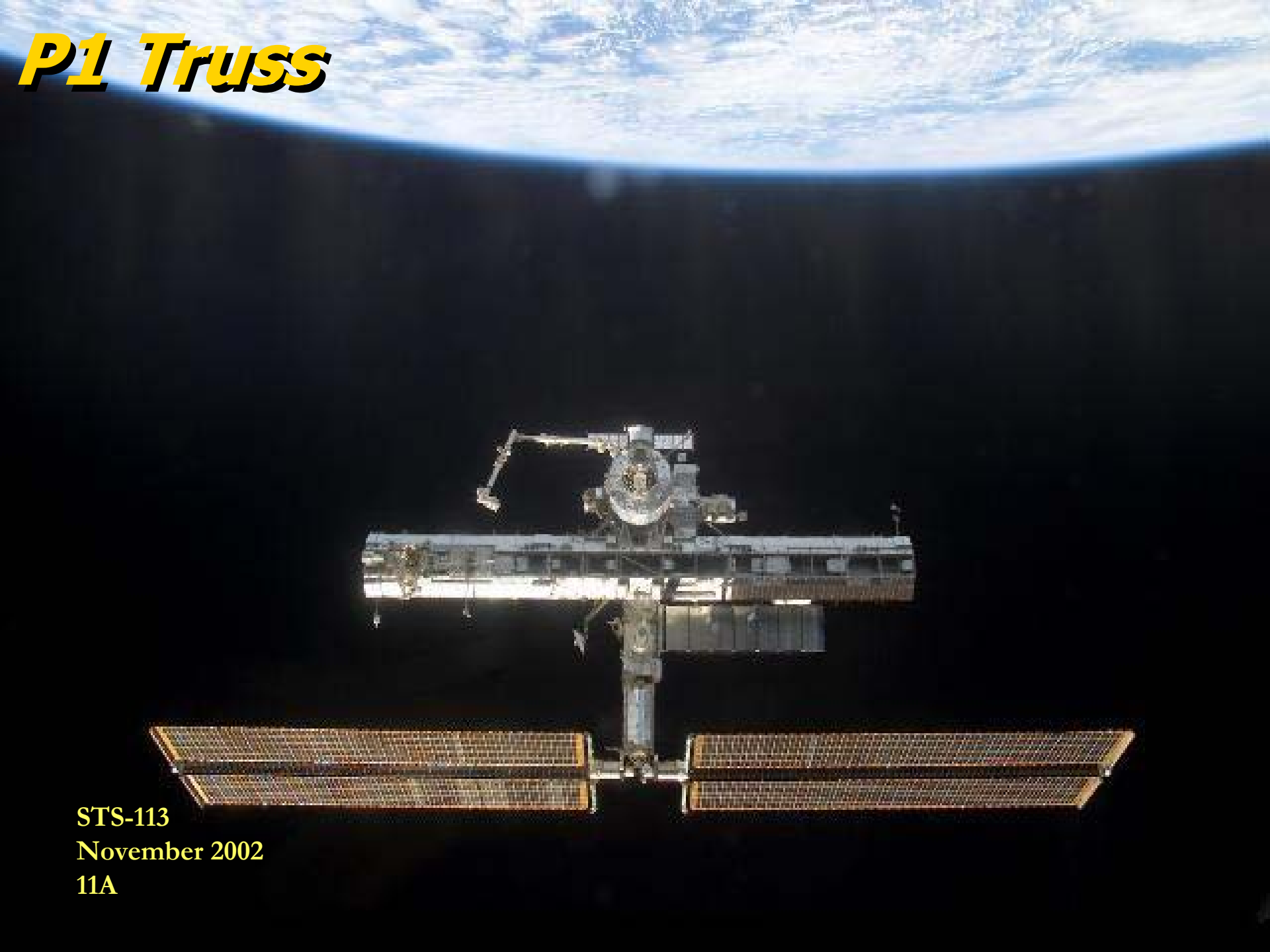
STS-110
April 2002
8A

S1 Truss



STS-112
October 2002
9A

P1 Truss



STS-113
November 2002
11A

What's Ahead

Solar Arrays

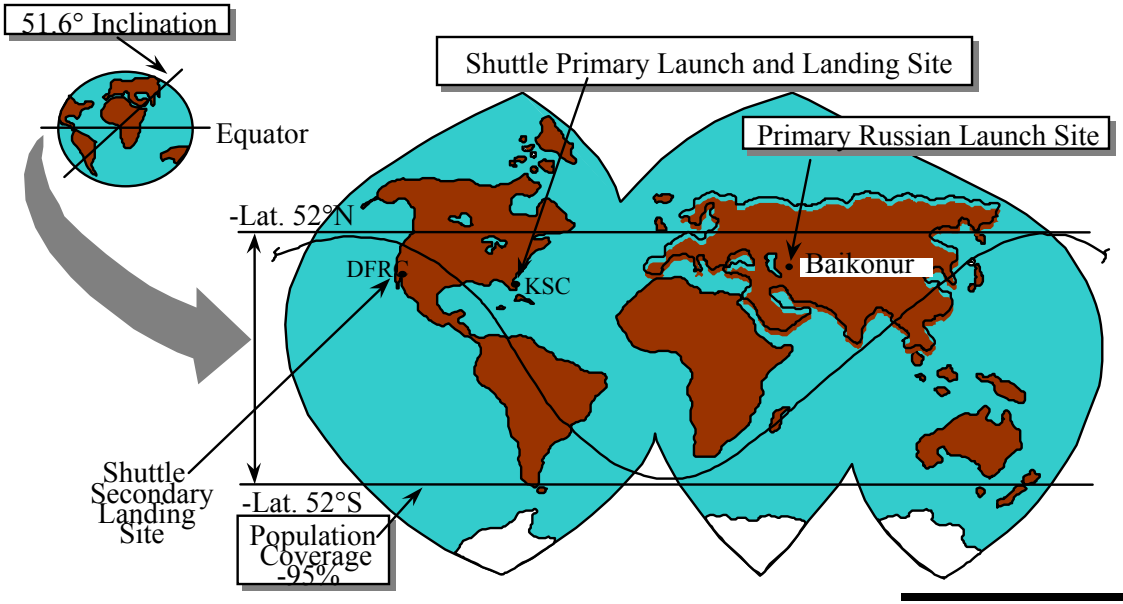
Crew Rotation/Utilization

- 12A.1 (Expedition 8, ICC)
- 13A.1 (Expedition 9, ICC)
- ULF-1 (MPLM, Expedition 7)

ISS Vehicle

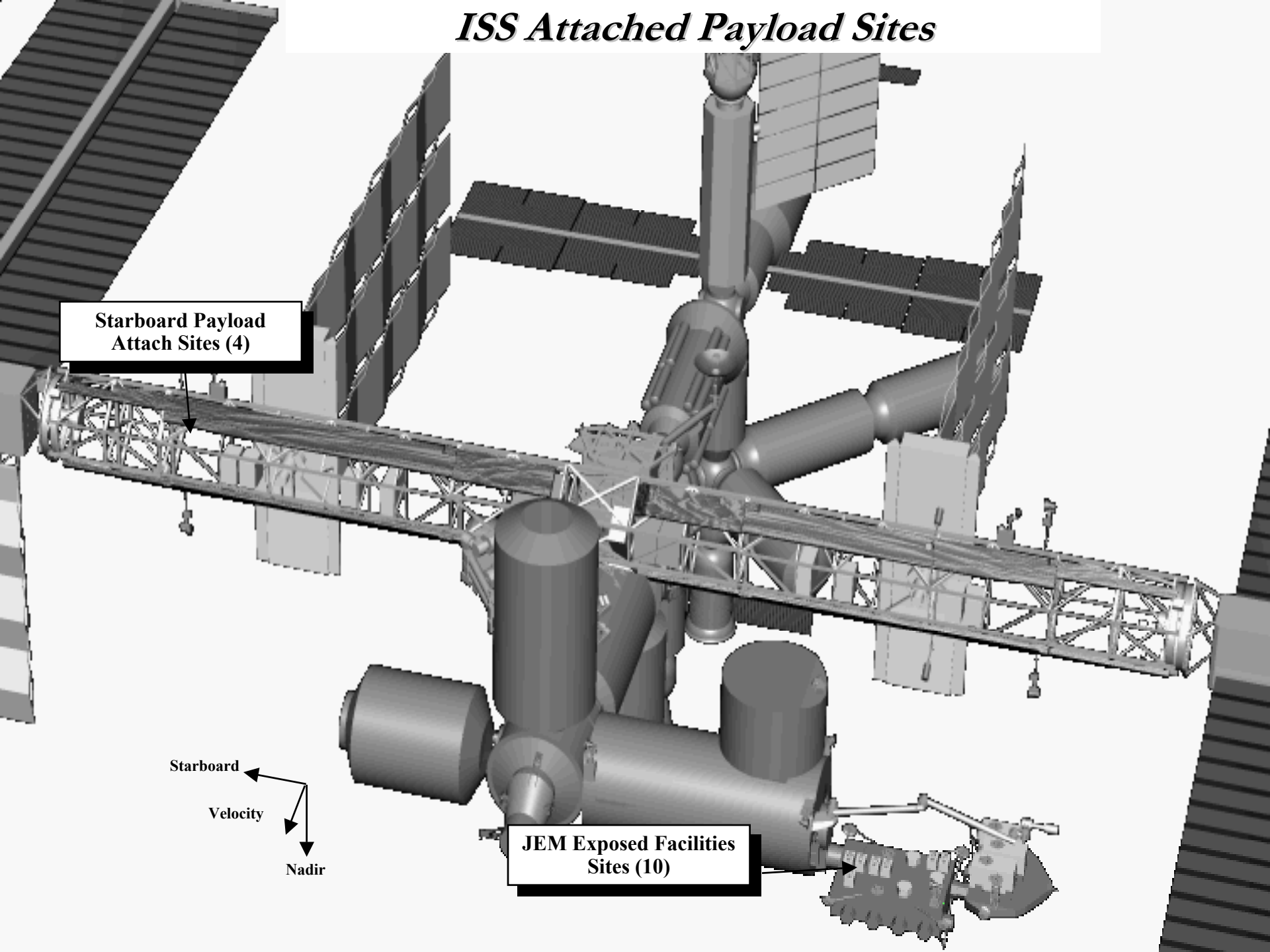
Orbit

- Nearly circular, inclination 51.6 deg
- Altitude 189 to 248 nautical miles (350 - 460 Km)
- Reaches maximum 52° latitude north and south
  - Covers 85% of globe, 95% Earth's population
- Flies over same spot approximately every 3 days, with the same lighting every 3 months

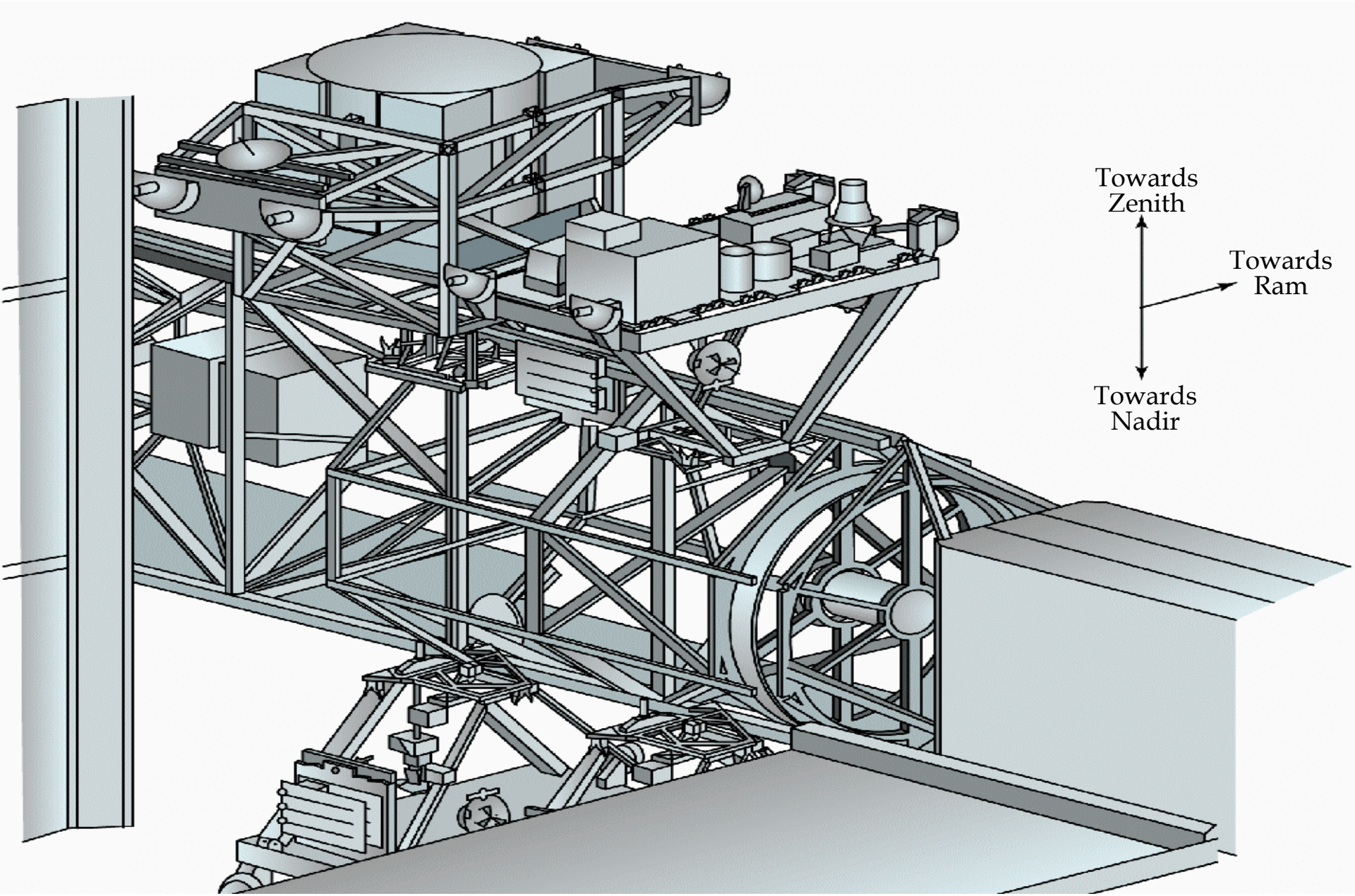


- Earth and Space Science ISS Payload Sites
  - Full Truss
  - EXPRESS Pallet
  - Japanese Experiment Module – Exposed Facility (JEM-EF)
  - Window Observational Research Facility (WORF)

ISS Attached Payload Sites



U.S. Truss



U.S. Truss - Full Attach Site

- 1 zenith site on starboard truss currently planned programmatically
- Mass
  - Dependent on payload center of gravity up to ~ 8,618 Kg (19,000 lbs)
- Payload envelope
  - 2.23m along truss
  - 5.0m ram/wake (Note: must consider STS Payload Bay Envelope)
  - Max height is 3.0m plus 1.39m of trapezoidal support structure
  - EVA translation corridors between payload and truss must be maintained
- Power
  - Max capability 3 kW
  - Actual power allocations less based on integrated payload vehicle requirements
  - Keep-alive power to be negotiated

U.S. Truss - Full Attach Site (Con't)

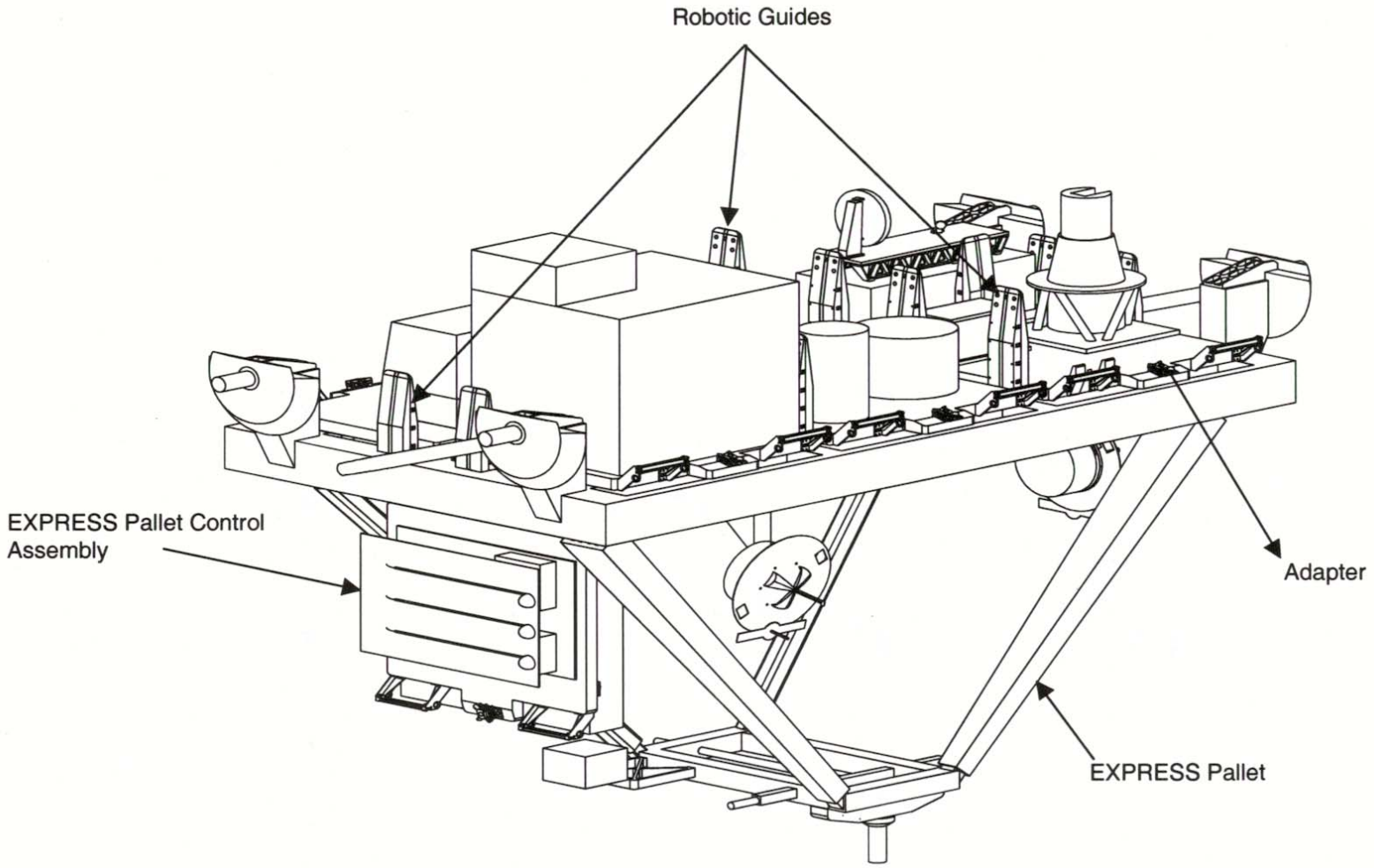
- Data
  - Low rate command, control, telemetry via MIL-STD-1553B bus, <100 kbps max
  - High rate data via fiber optic, upgrade to 150 Mbps burst under review
  - Downlink not real-time, at best every few orbits
- No active thermal control provided
- Robotic installation and retrieval primary, EVA contingency
- Carrier
  - Must provide own structure on-orbit
  - Over 2500 Kg, payload provides carrier/interface to Shuttle

Pointing at U.S. Truss Sites

Pointing

- Knowledge 0.1 deg at GPS sites
  - Degrades with distance to ~1-2 deg at S3 attach sites
- Stability 2.5 deg/axis/orbit
  - Pointers are being developed for specific EXPRESS Pallet adapter payloads

EXPRESS Pallet

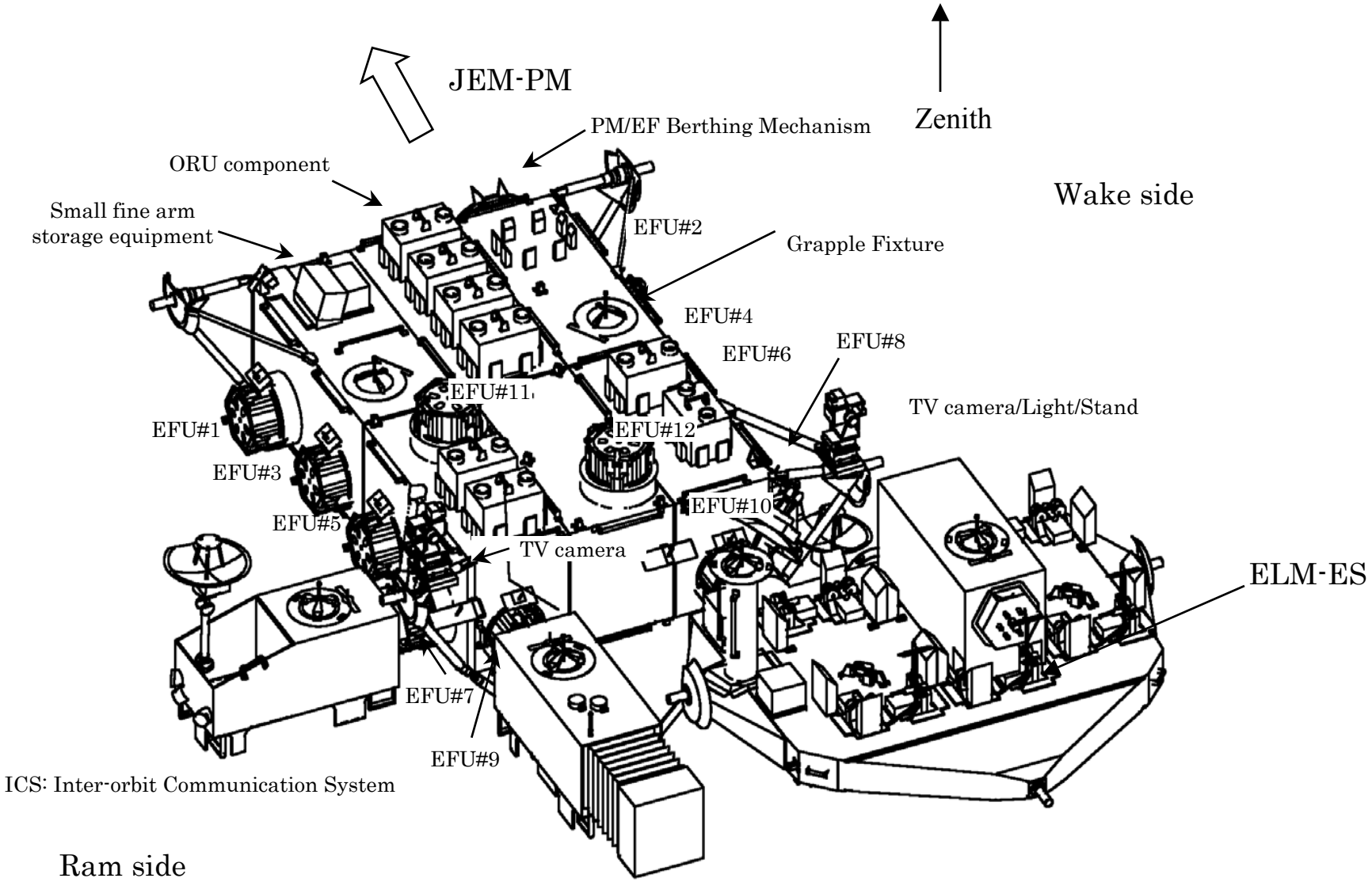


U.S. Truss - EXPRESS Pallet

- Status of pallet program is being worked within NASA
- 2 nadir pallets and 1 zenith pallet on starboard truss currently planned
- 6 adapter plates per pallet
  - Capability for 2 payload per adapter plate
- All sites are allocated to NASA
  - Exceptions for barter arrangements with International Partners
- Mass 227 Kg per adapter payload
- Payload Envelope
  - 1.1m ram/wake
  - 0.86m inboard/outboard
  - 1.2m zenith/nadir
- Power
  - 120 Vdc or 28 Vdc available
  - 550 W per adapter @ 120 Vdc

U.S. Truss - EXPRESS Pallet (Con't)

- Data
  - MIL-STD-1553B and high rate Ethernet, analog and discrete
  - 6 payloads multiplex through EXPRESS Pallet Control Assembly
    - Currently limited to 6 Mbps
  - All payloads multiplex with vehicle data into KU band
    - Total 43 Mbps
- No thermal control provided by Pallet
- Robotic installation and retrieval primary, Extravehicular Activity (EVA) contingency
- Carrier
  - First payload set launches on Pallets
  - Returning payloads and future individual payloads ride on carriers provided by ISS Program



Japanese Experiment Module- Exposed Facility

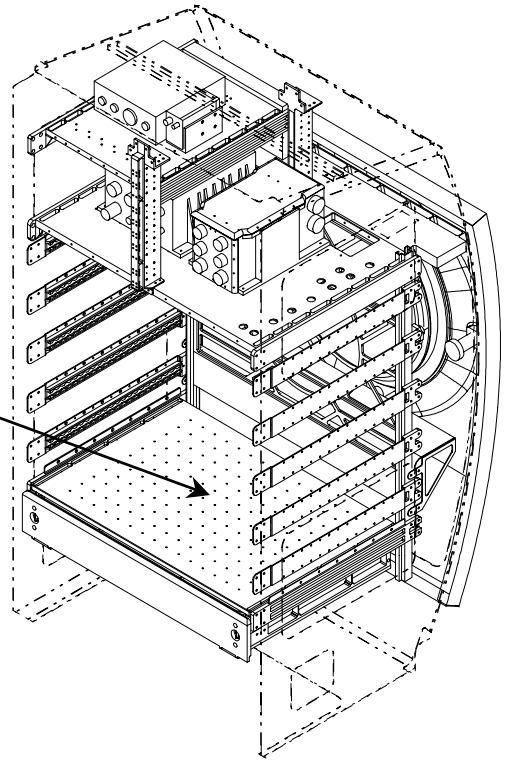
Japanese Experiment Module - Exposed Facility (JEM-EF)

- 10 payload sites - 5 NASA, 5 NASDA
  - 8 sites can view zenith and nadir simultaneously, 2 zenith viewing only
- Mass
  - Eight 500 Kg sites
  - Two 2500 Kg sites: EFU#2 and EFU#9, payload transport/installation issues exist
- Payload envelope
  - 1.85m ram/wake
  - 0.8m inboard/outboard
  - 1.0m zenith/nadir
- Power and data site dependent
  - Generally 3 kW per site
  - 100 W keep-alive power
  - MIL-STD-1553B bus, high rate Ethernet available

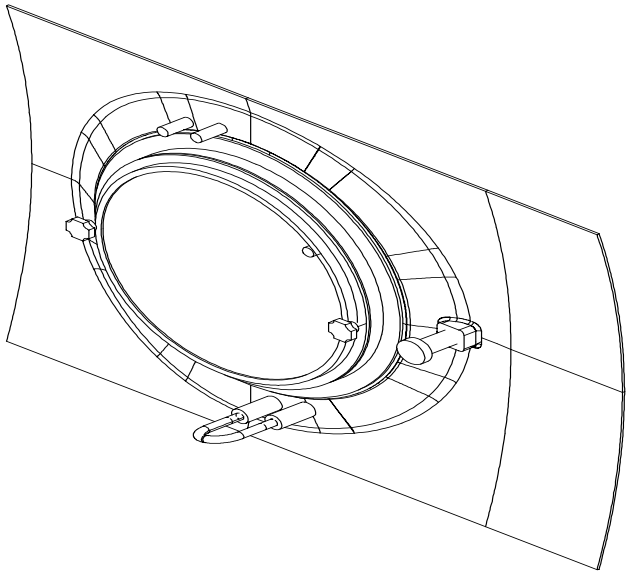
JEM-EF

- Active thermal cooling available
- Robotic installation
  - Grapple fixture must be located on zenith face
- Carrier
  - Launched by STS with ULC
  - 2nd option launched by Japanese HTV with Mixed Logistics Carrier
  - Must return via STS with ULC
- Capability for crew access via JEM airlock

Window Observational Research Facility (WORF)

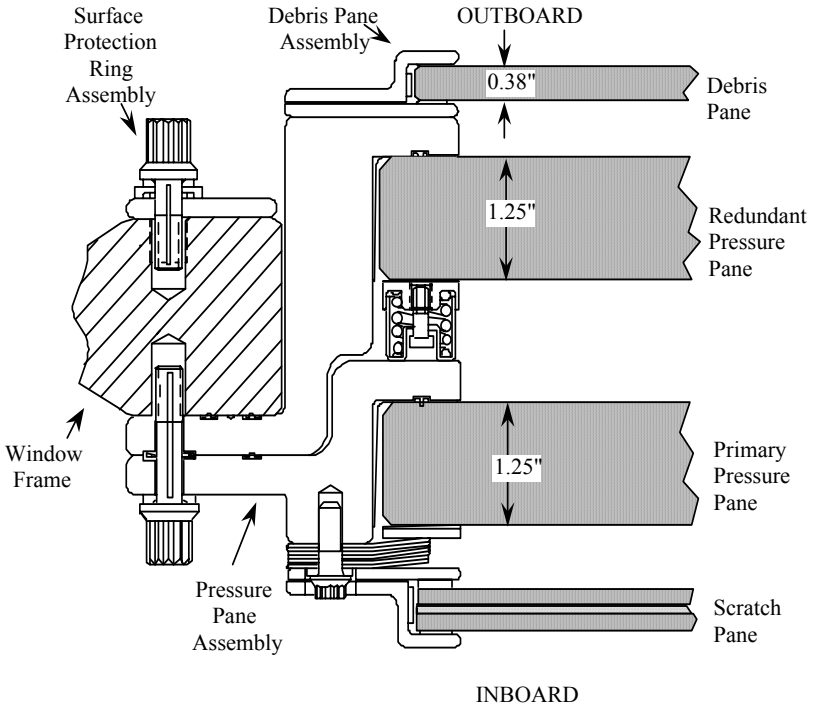


WORF 3/4 schematic view showing the relationship between payload volume and avionics bays.

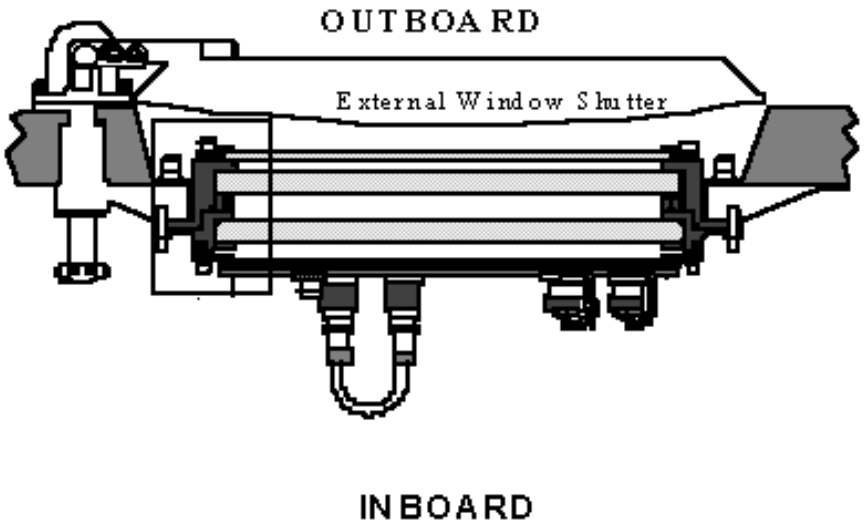


US Laboratory nadir window; the pane has a 20” (50.8cm) clear viewing area. To the right of the window is the hand wheel for opening the window shutter. The “U”-shaped structure below the window is a quick disconnect (QD) that controls the pressure between the two pressure panes.

ISS WORF

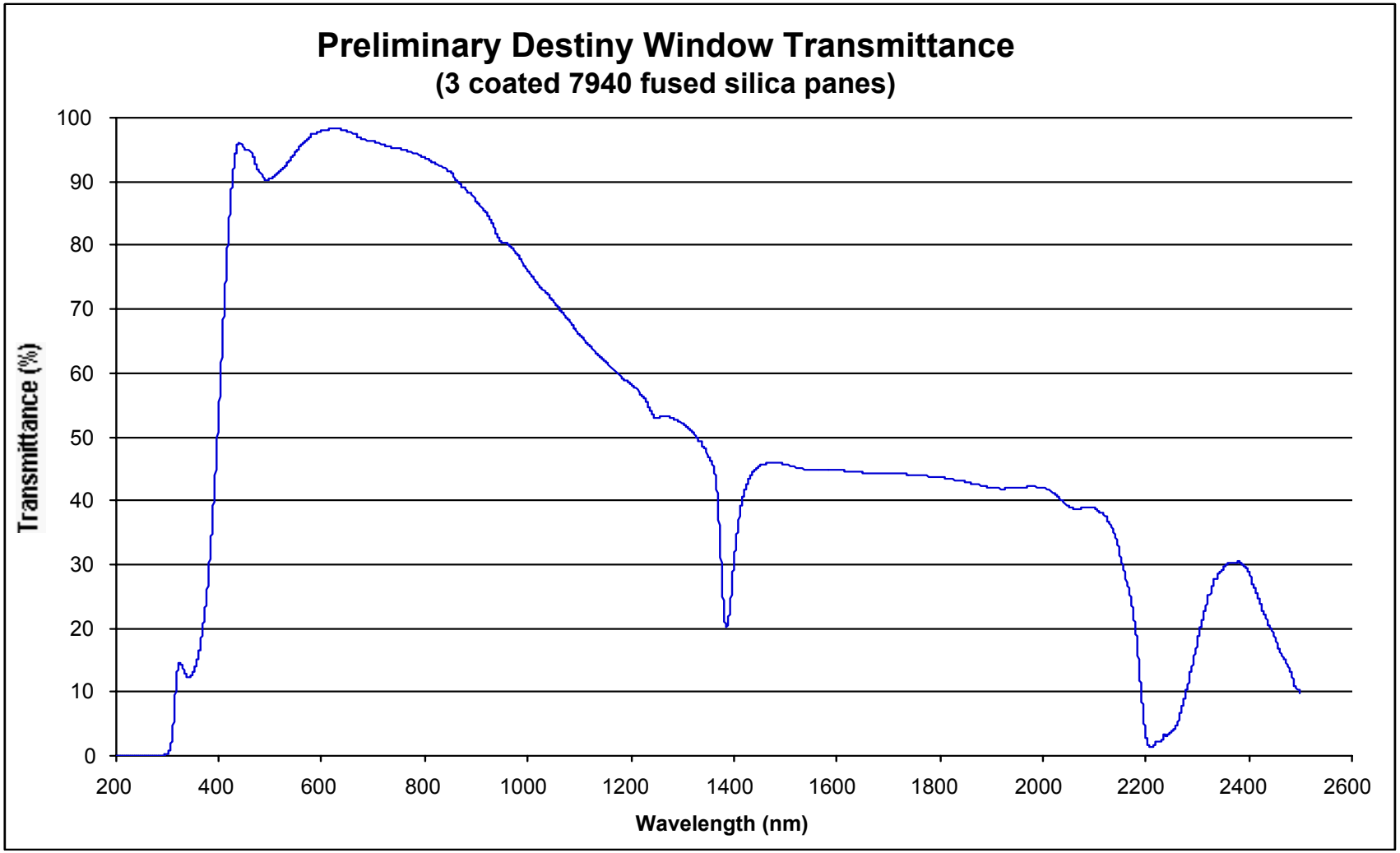


Schematic showing the construction of the nadir window and its Integration into the window mount. The kick pane will be removed for during window research operations.



Window/mount integration into the Space Station structure. The external cover can be moved out of the way by use of the hand wheel located to the left.

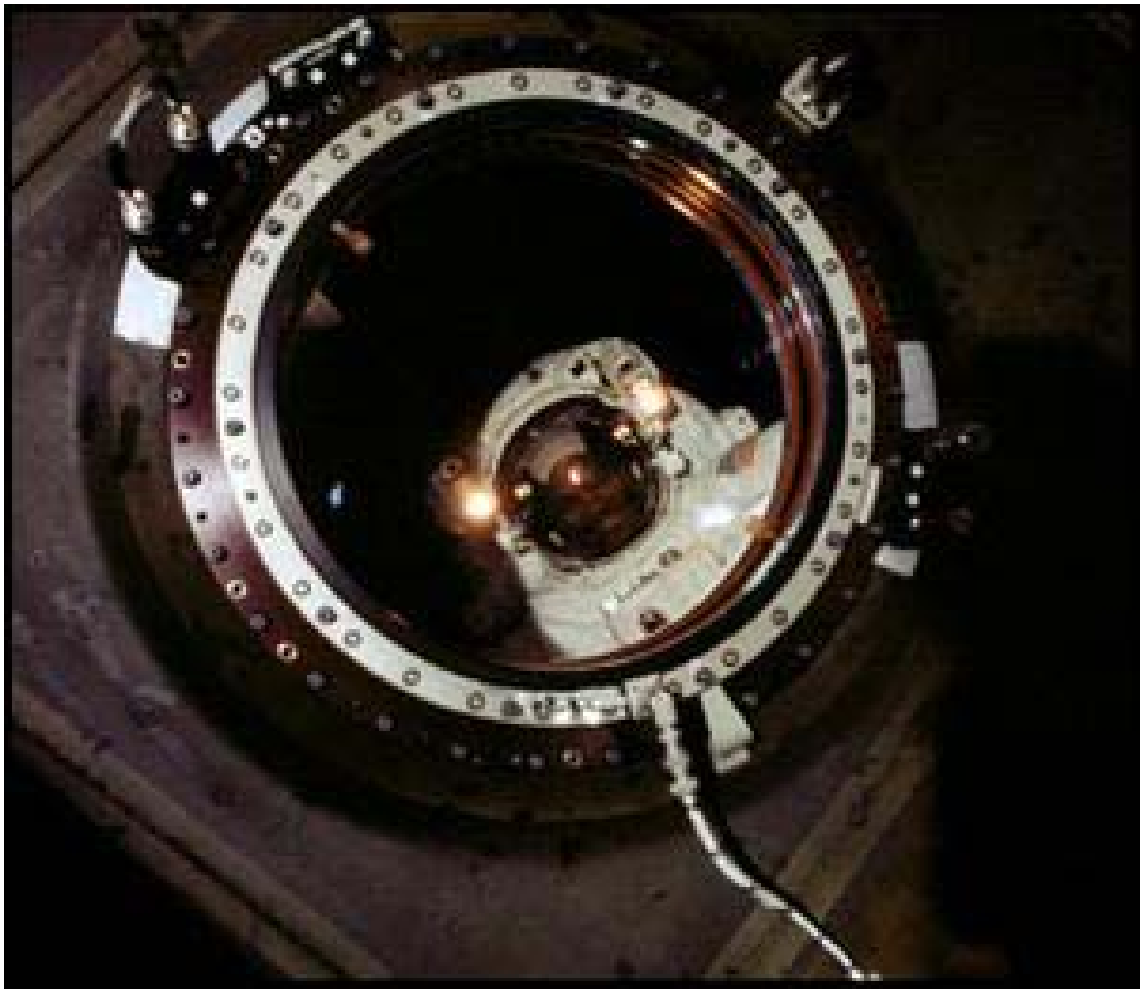
Window Transmittance Curve



ISS WORF

- 20-inch fused silica diameter window located in nadir side of the US Laboratory Module
- Optical quality of window is superior to any window flown on a manned mission
  - Measured optical quality confirms wave front error of λ / 14 over 6-inches, peak to valley, reference λ = 632.8nm, with scratch pane removed for payload operations
- WORF rack adjacent to window provides support infrastructure for camera/remote sensor operations

Window on Orbit



ISS WORF

- Mass
  - 136 Kg
- Payload Envelope
  - 53.3cm x 76.2cm x 50.8cm
- Power
  - 28 Vdc, 560 W maximum to any payload interface
  - 2 kW total available for payloads
    - Thermal system capacity determines allowable power draw
- Data
  - Maximum data rate 10 Mbps with approximately 9 Gb storage in the Biological Research Project (BRP) Express Memory Unit (BEMU)
  - Low, medium, and high rate telemetry and video available
- Payloads can be operated in any combination of crew operated, crew tended, ground commanded, or fully autonomous

General ISS Payload Considerations: Manned Flight Safety

- STS and ISS safety review system combined for flight and ground
- Substantial documentation increase over Expendable Launch Vehicles (ELV)
- Significant safety oversight required
  - Safety and hazard verification
- Level of rigor independent of payload size or $ value
  - 3 step review process
  - Phase 1 review within 3 months of PDR

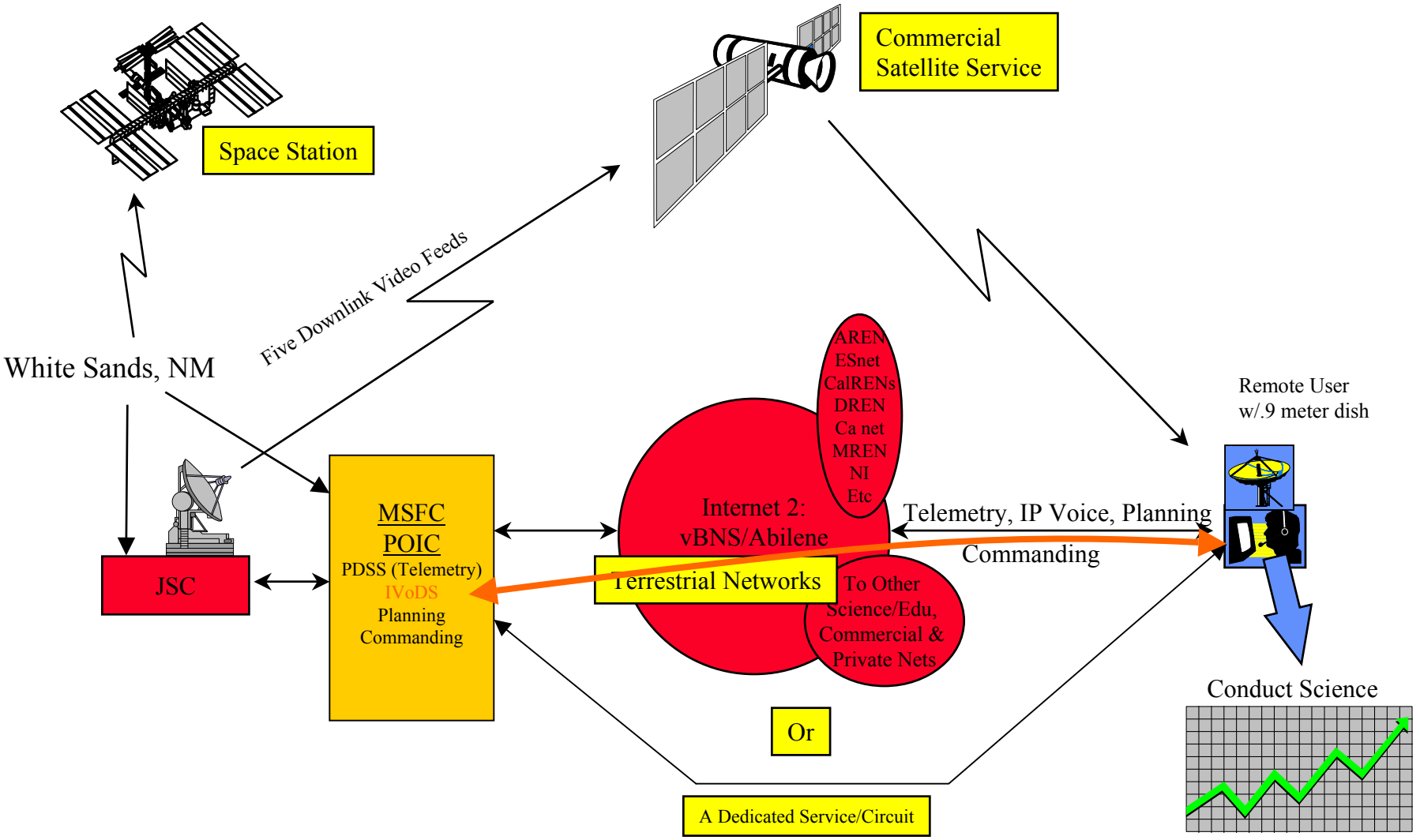
General ISS Payload Considerations: Crew Training

- "Standard" operations don't require Payload Developer (PD) input, e.g. robotic placement
- Unique payload handling on-orbit requires training procedures, documentation
- Crew familiarization package to be provided by PD
- Contingency operations involving crew intervention will require ground or on-board training

General ISS Payload Considerations: Ops Concept

- PI operates payload and receives data through MSFC via a workstation at a secure location of PI's choice
- Increment = crew rotation period, ~ 3 months
- Planning Period ~ 1 year
- "Increment Scientist" (IS) represents all Code S or Y payloads operating on ISS for a planning period and works directly with PIs
- IS is part of a team with a Lead Increment Scientist who represents all payloads to ISS Program during ops and contingencies
- Reporting required after each increment with additional post flight reporting

ISS TO SCIENCE USER END TO END CONNECTIVITY



General ISS Payload Considerations: Retrieval

- Payloads must be returned to ground
- Retrieval planning must take place prior to launch
- Payload anomalies and configuration changes must be tracked while on-orbit
- Safety re-assessment requires original design documents and operations records be maintained
- Retrieval Certification of Flight Readiness (CoFR) and Safety review required
- De-integrate from STS and return payload to PI

Manifest Schedule

Payloads for U.S. Truss not manifested before Fall 2005

JEM-EF manifested in 2007

WORF scheduled for launch in 2003

EXPRESS Pallets: First Pallet (Nadir) manifested in 2006
Second Pallet (Zenith) manifested in early 2008

Note: All dates are pre-Columbia
EXPRESS Pallet funding not yet finalized

Additional Information

Program Automated Library System (PALS)

- PALS web site: http://iss-www.jsc.nasa.gov/ss/issapt/pals/
- Online Access READ-ONLY Request Form

International Space Station Payload Information Source

- Web site: http://stationpayloads.jsc.nasa.gov/index.html
- Various station reference documents
  - Payload safety, payload integration agreements, interface requirements and verification, payload accommodations handbooks
- ISS Payload Documentation Tree
  - Defines the requirements, processes, and products for the Payload Integration process

Contact Us

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